The “birth hump”
A shape decomposition of perinatal excess mortality

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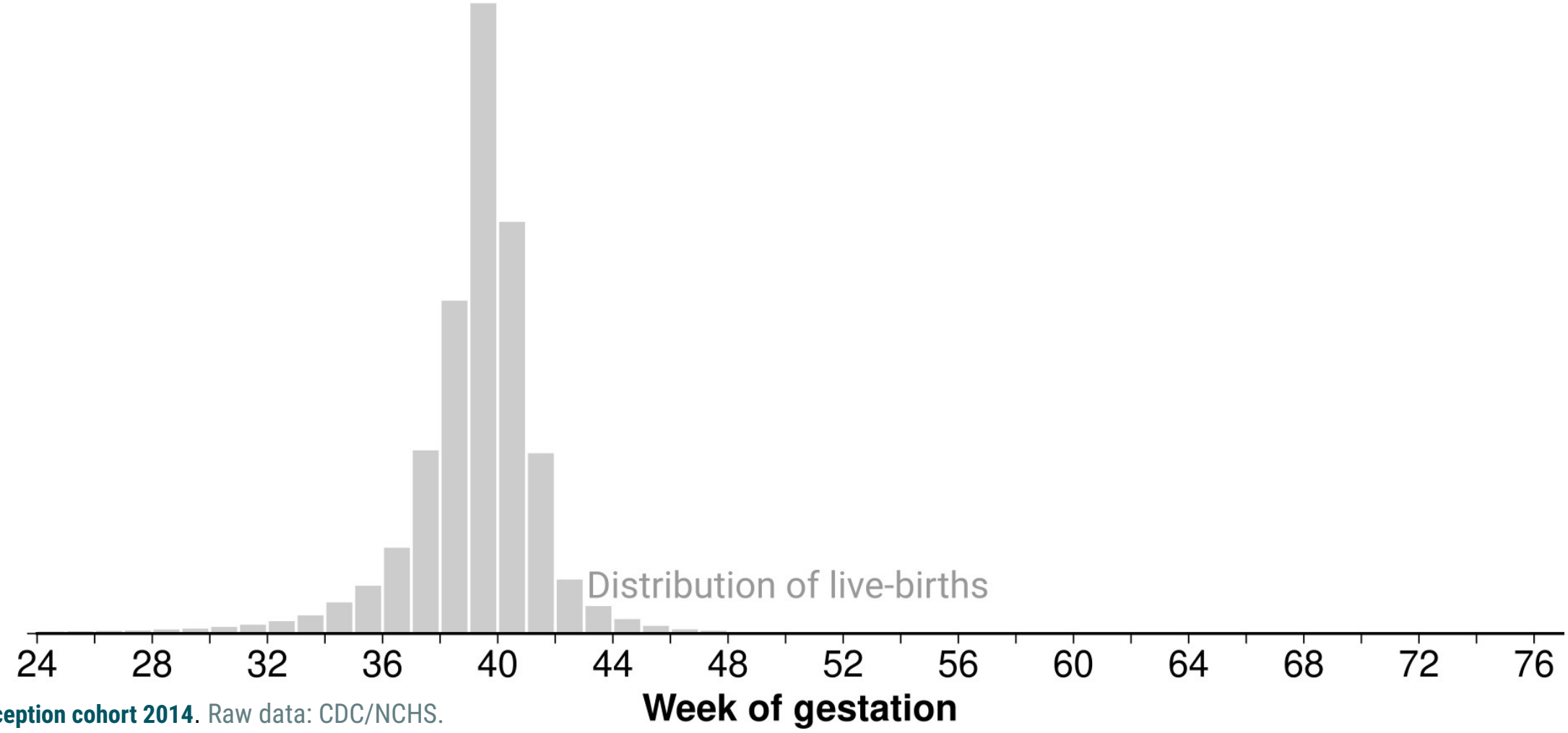
FOR DEMOGRAPHIC RESEARCH

The transitional shock of birth



US conception cohort 2014. Raw data: CDC/NCHS.

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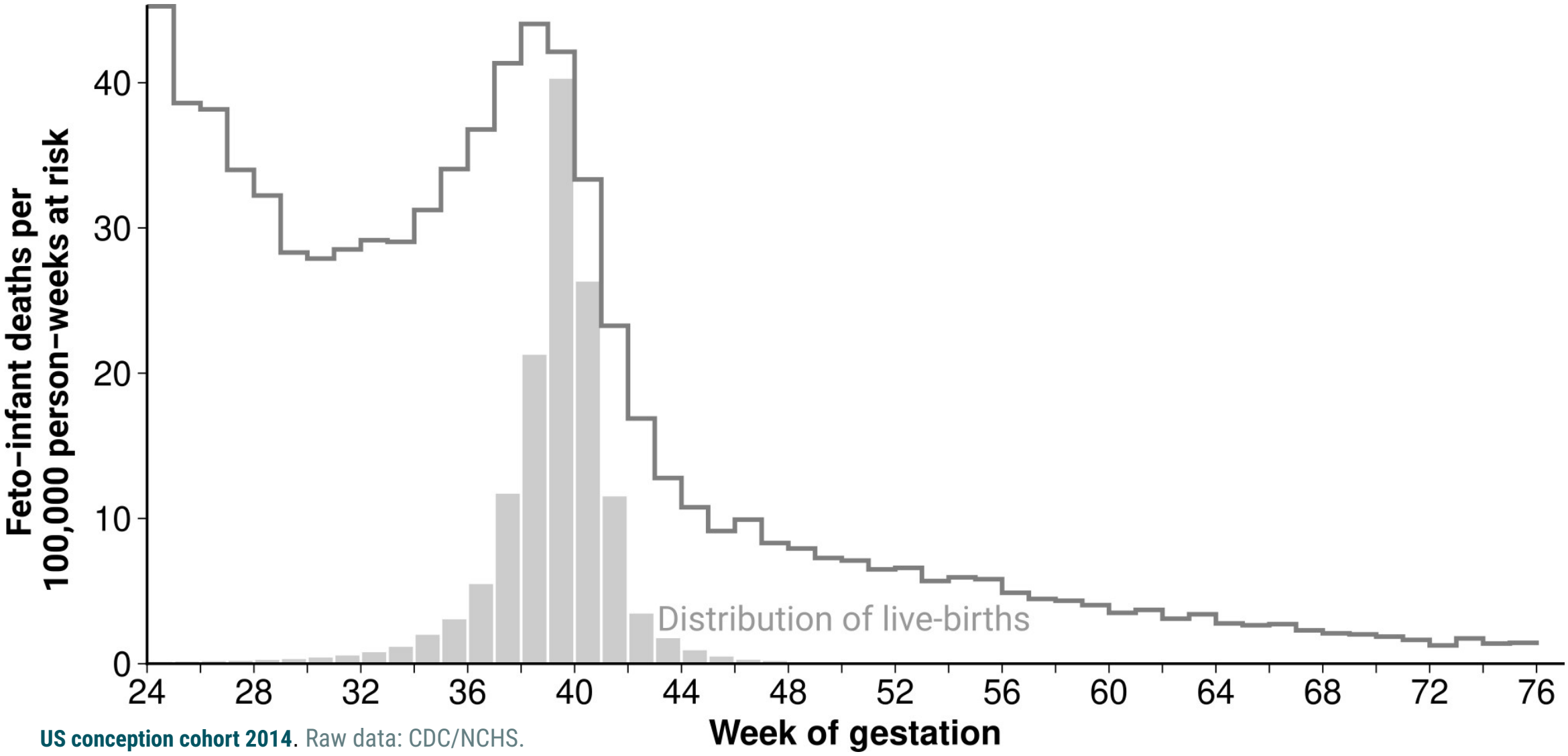

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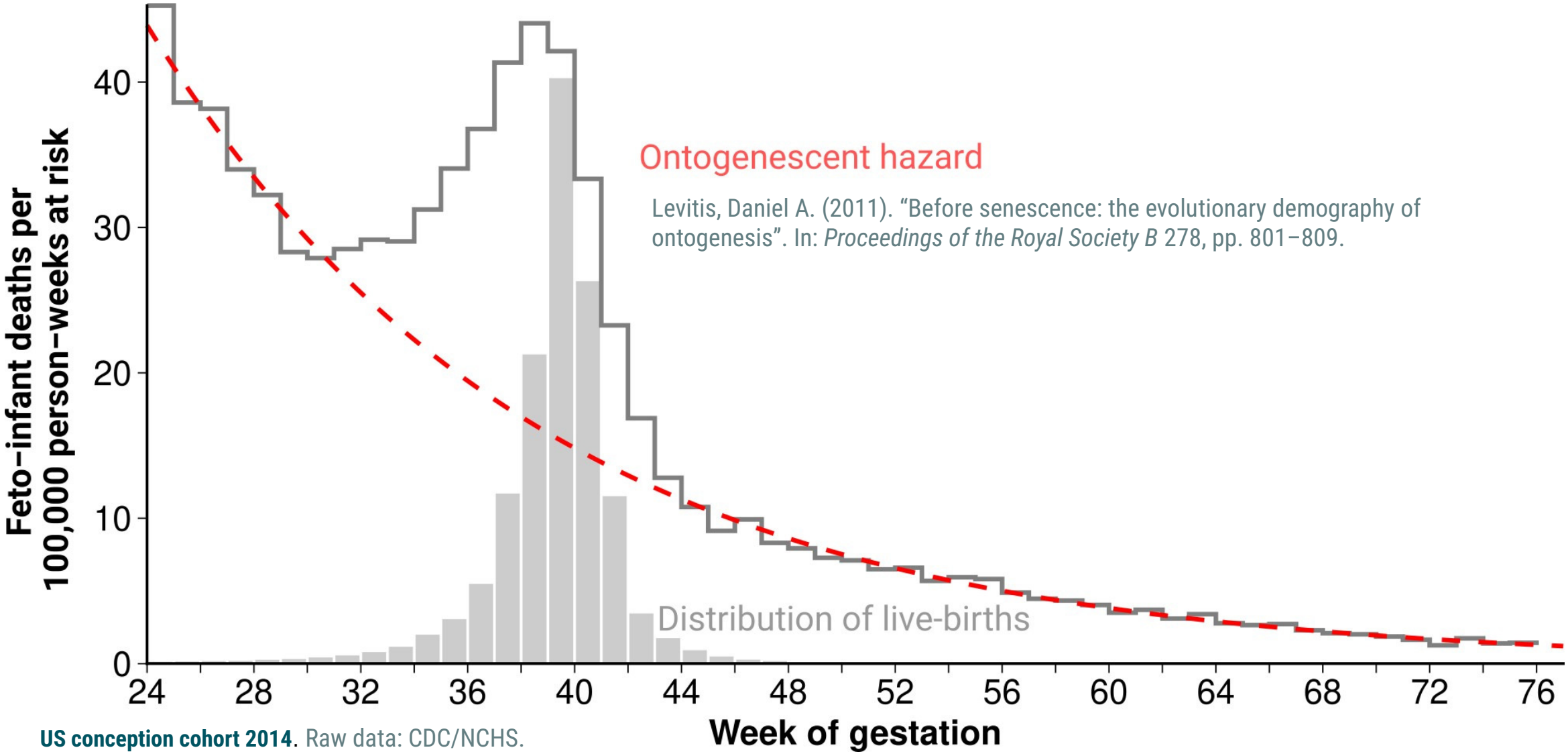

Levitis, Daniel A. (2011). "Before senescence: the evolutionary demography of ontogenesis". In: *Proceedings of the Royal Society B* 278, pp. 801–809.

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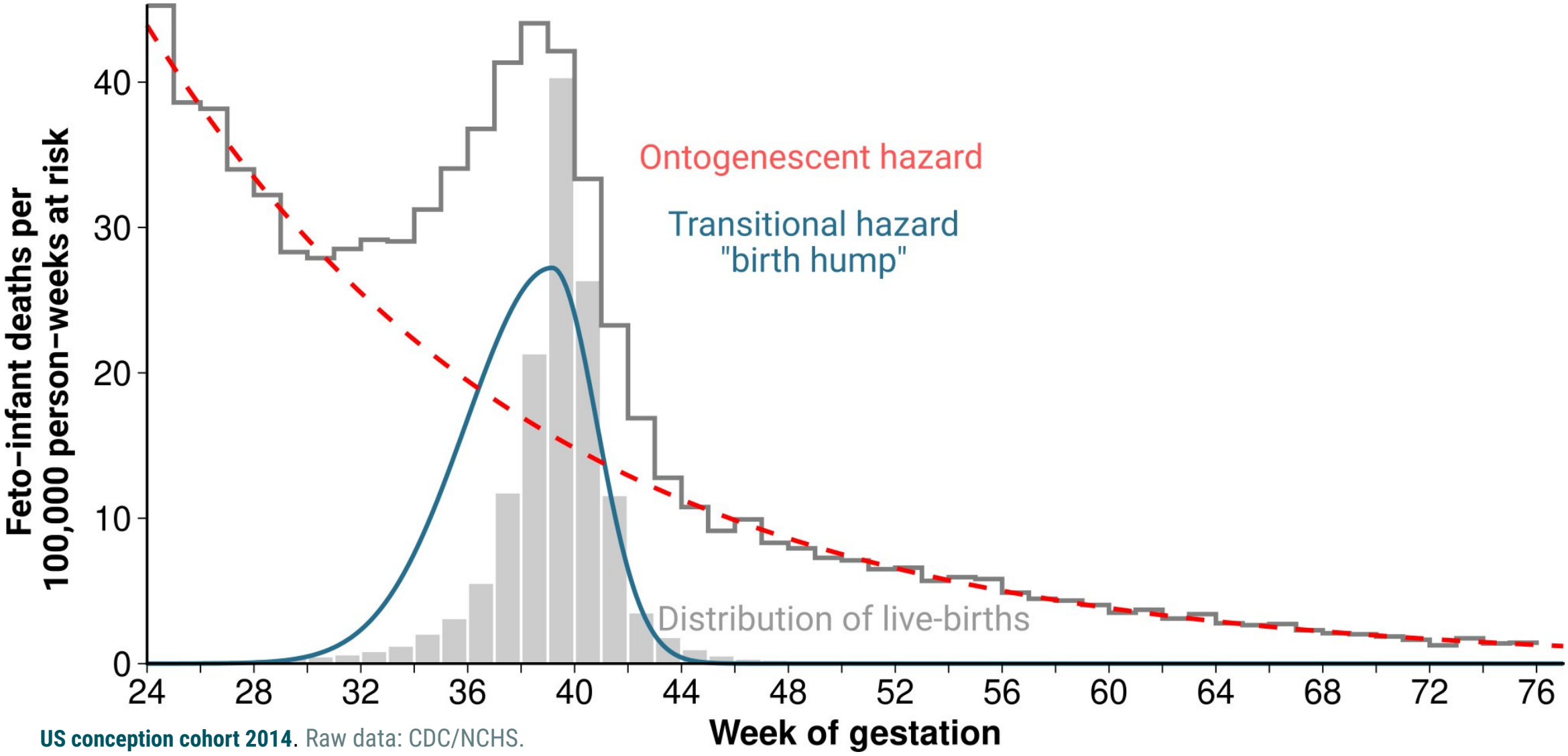

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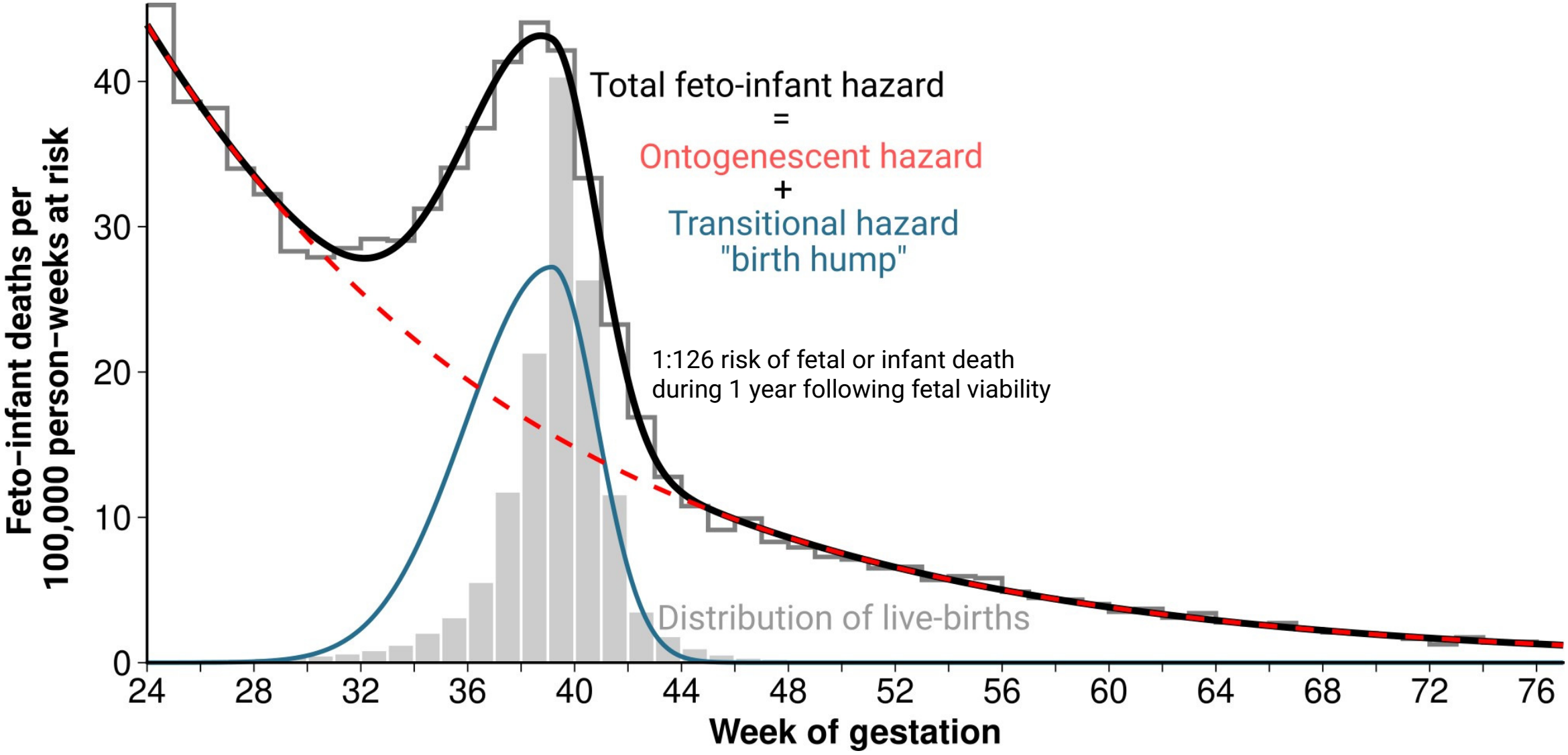
The transitional shock of birth

Combined feto-infant mortality by week of gestation among conception cohort 2014. *The dynamics of ontogenescence.* Raw data: CDC/NCHS.



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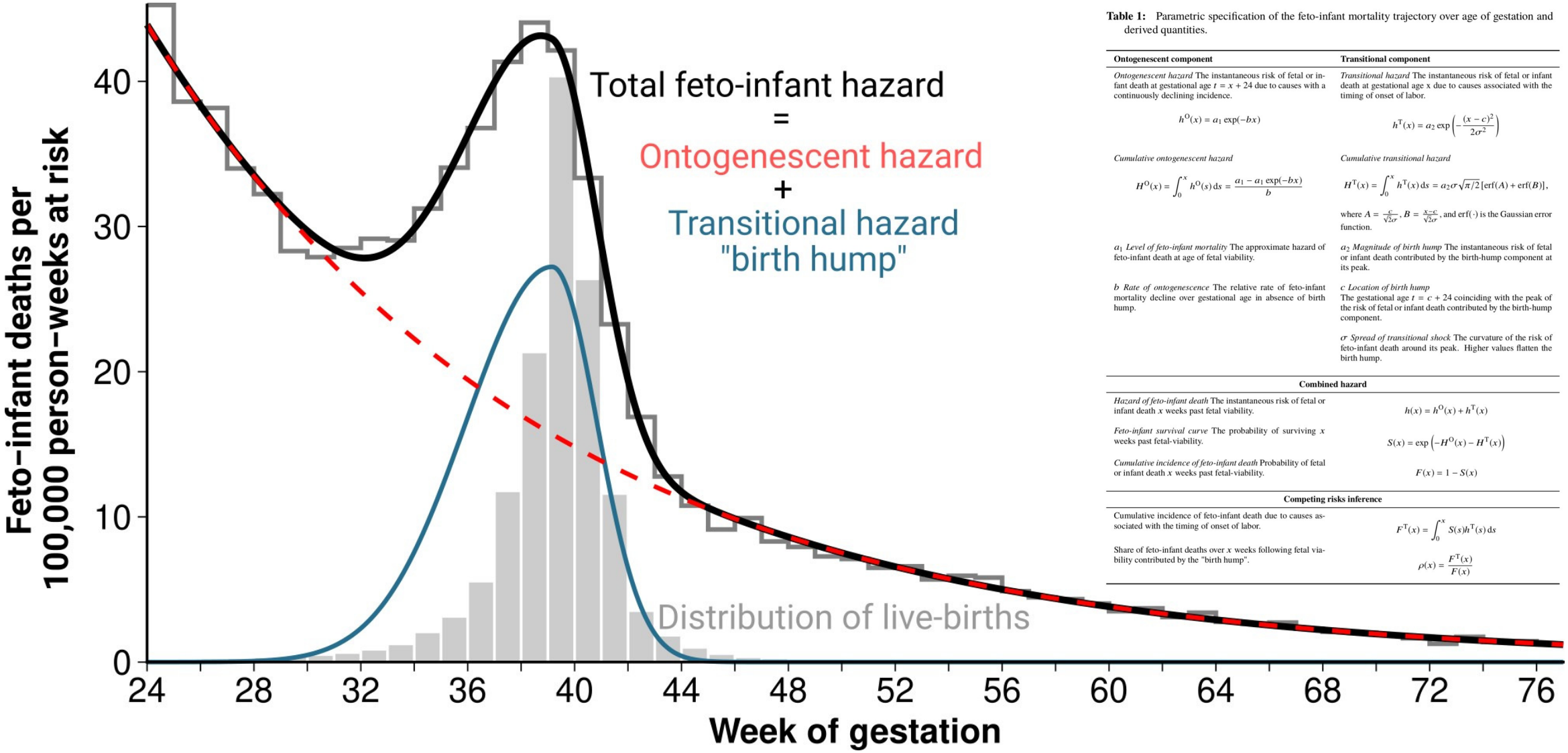
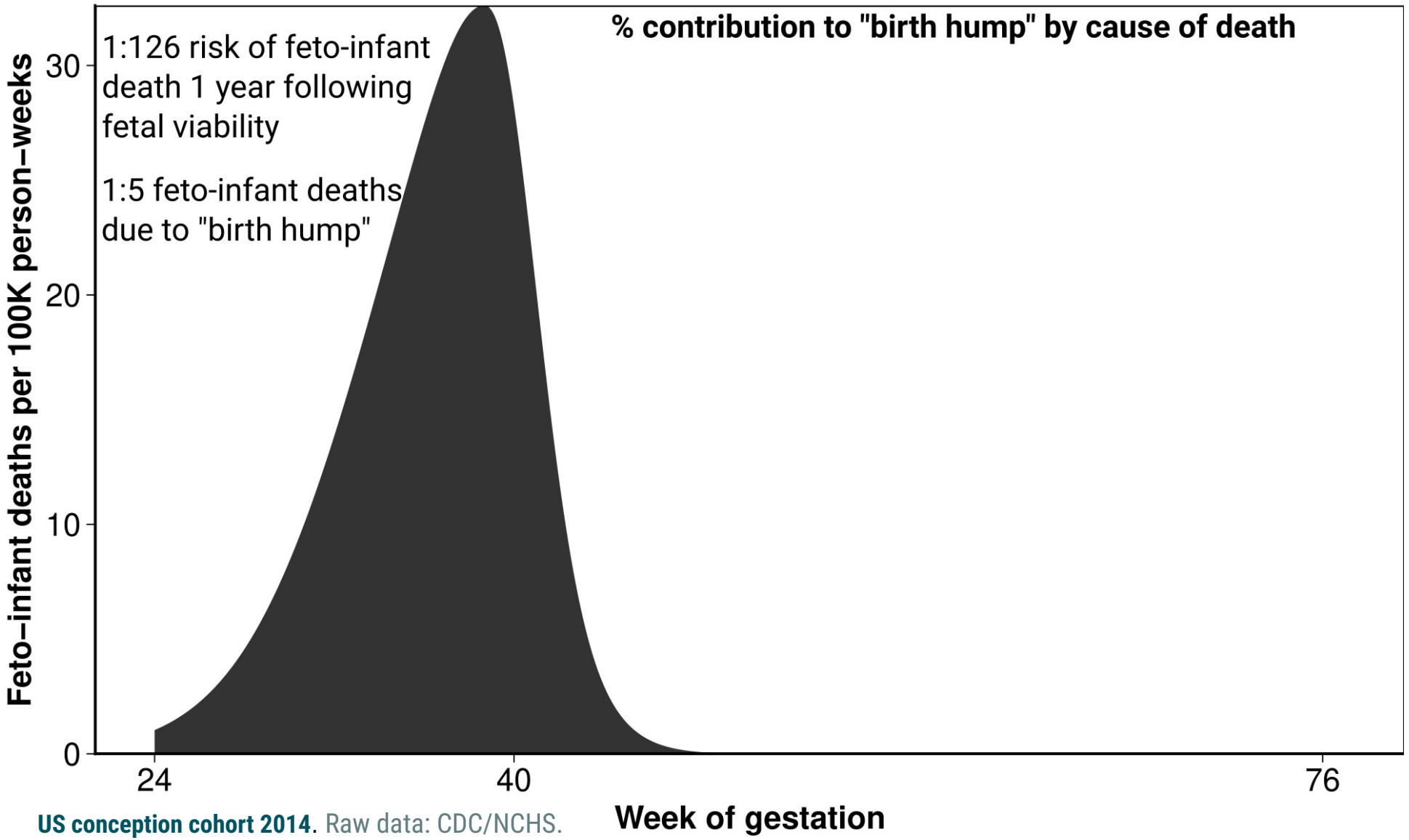


Table 1: Parametric specification of the feto-infant mortality trajectory over age of gestation and derived quantities.

Ontogenescent component	Transitional component
Ontogenescent hazard The instantaneous risk of fetal or infant death at gestational age $t = x + 24$ due to causes with a continuously declining incidence. $h^{O}(x) = a_1 \exp(-bx)$	*Transitional hazard* The instantaneous risk of fetal or infant death at gestational age x due to causes associated with the timing of onset of labor. $h^{T}(x) = a_2 \exp\left(-\frac{(x-c)^2}{2\sigma^2}\right)$
Cumulative ontogenescent hazard $H^{O}(x) = \int_0^x h^{O}(s)\,ds = \frac{a_1 - a_1 \exp(-bx)}{b}$	*Cumulative transitional hazard* $H^{T}(x) = \int_0^x h^{T}(x)\,ds = a_2\sigma\sqrt{\pi/2}\,[\mathrm{erf}(A) + \mathrm{erf}(B)]$, where $A = \frac{c}{\sqrt{2}\sigma}$, $B = \frac{x-c}{\sqrt{2}\sigma}$, and $\mathrm{erf}(\cdot)$ is the Gaussian error function.
a_1 *Level of feto-infant mortality* The approximate hazard of feto-infant death at age of fetal viability.	a_2 *Magnitude of birth hump* The instantaneous risk of fetal or infant death contributed by the birth-hump component at its peak.
b *Rate of ontogenescence* The relative rate of feto-infant mortality decline over gestational age in absence of birth hump.	c *Location of birth hump* The gestational age $t = c + 24$ coinciding with the peak of the risk of fetal or infant death contributed by the birth-hump component.
	σ *Spread of transitional shock* The curvature of the risk of feto-infant death around its peak. Higher values flatten the birth hump.
Combined hazard	
Hazard of feto-infant death The instantaneous risk of fetal or infant death x weeks past fetal viability. $h(x) = h^{O}(x) + h^{T}(x)$	
Feto-infant survival curve The probability of surviving x weeks past fetal-viability. $S(x) = \exp\left(-H^{O}(x) - H^{T}(x)\right)$	
Cumulative incidence of feto-infant death Probability of fetal or infant death x weeks past fetal-viability. $F(x) = 1 - S(x)$	
Competing risks inference	
Cumulative incidence of feto-infant death due to causes associated with the timing of onset of labor. $F^{T}(x) = \int_0^x S(s)h^{T}(s)\,ds$	
Share of feto-infant deaths over x weeks following fetal viability contributed by the "birth hump". $\rho(x) = \frac{F^{T}(x)}{F(x)}$	

Deconstructing the “birth hump”



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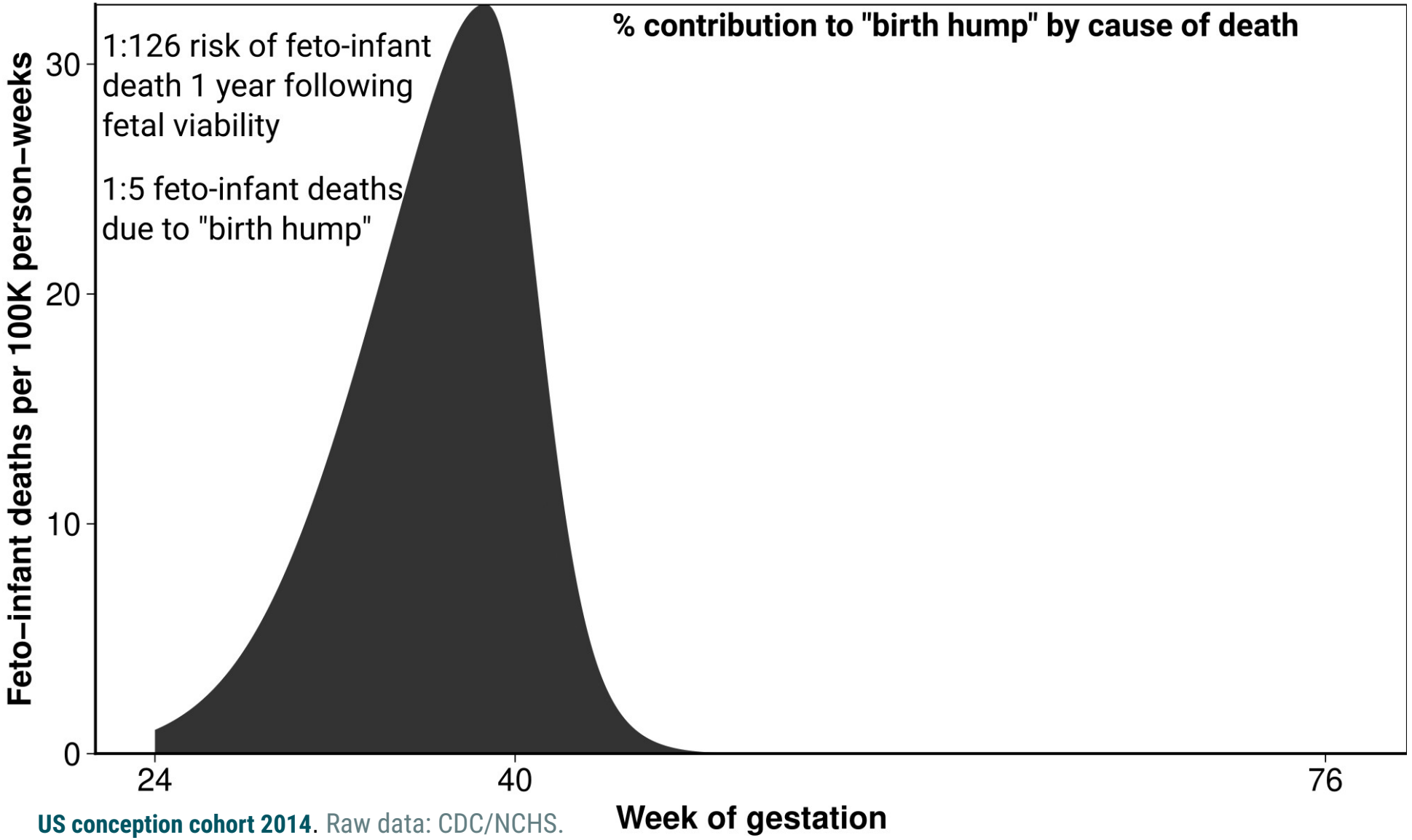

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If a child dies in relation to the transition of birth, **what do they die of?**

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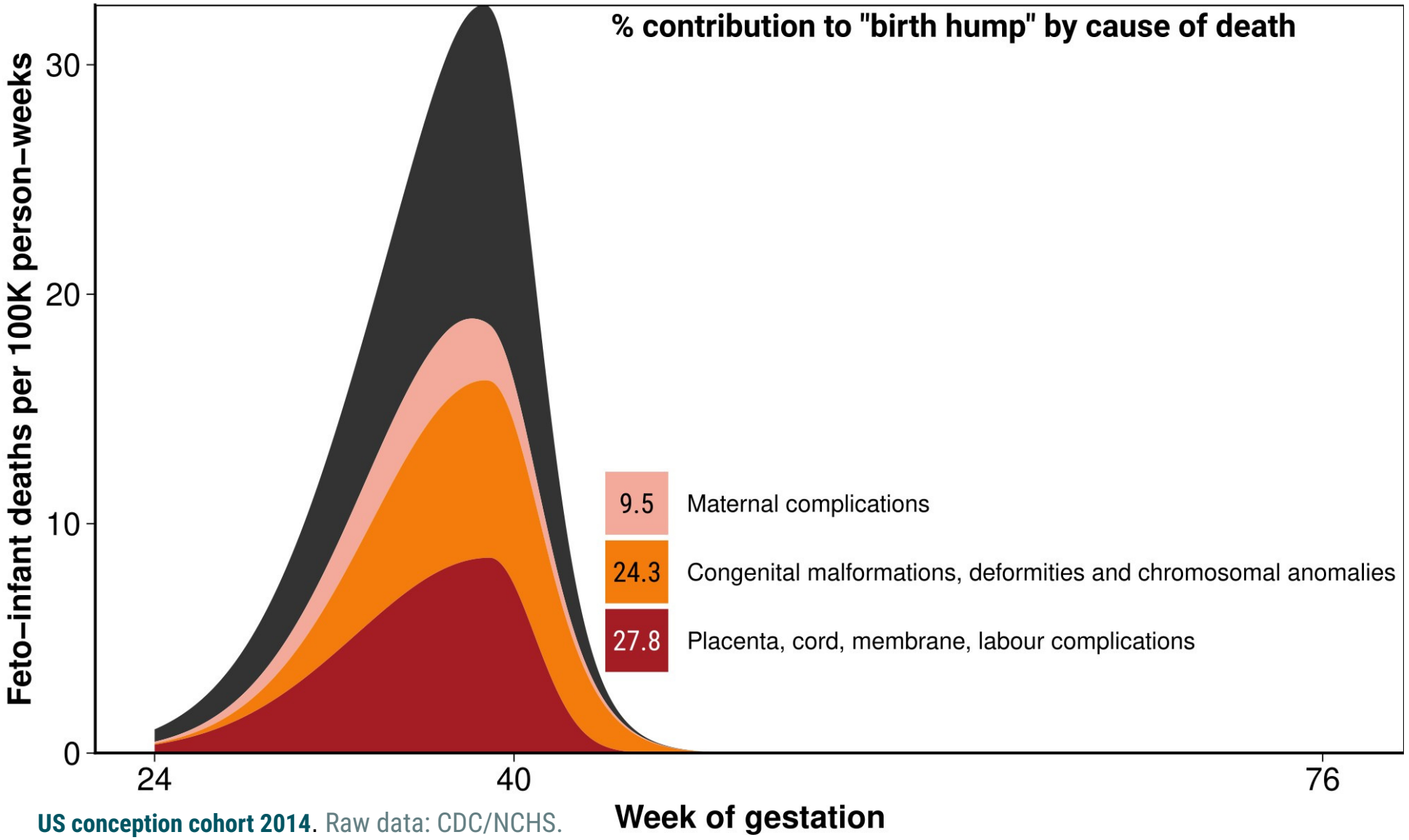

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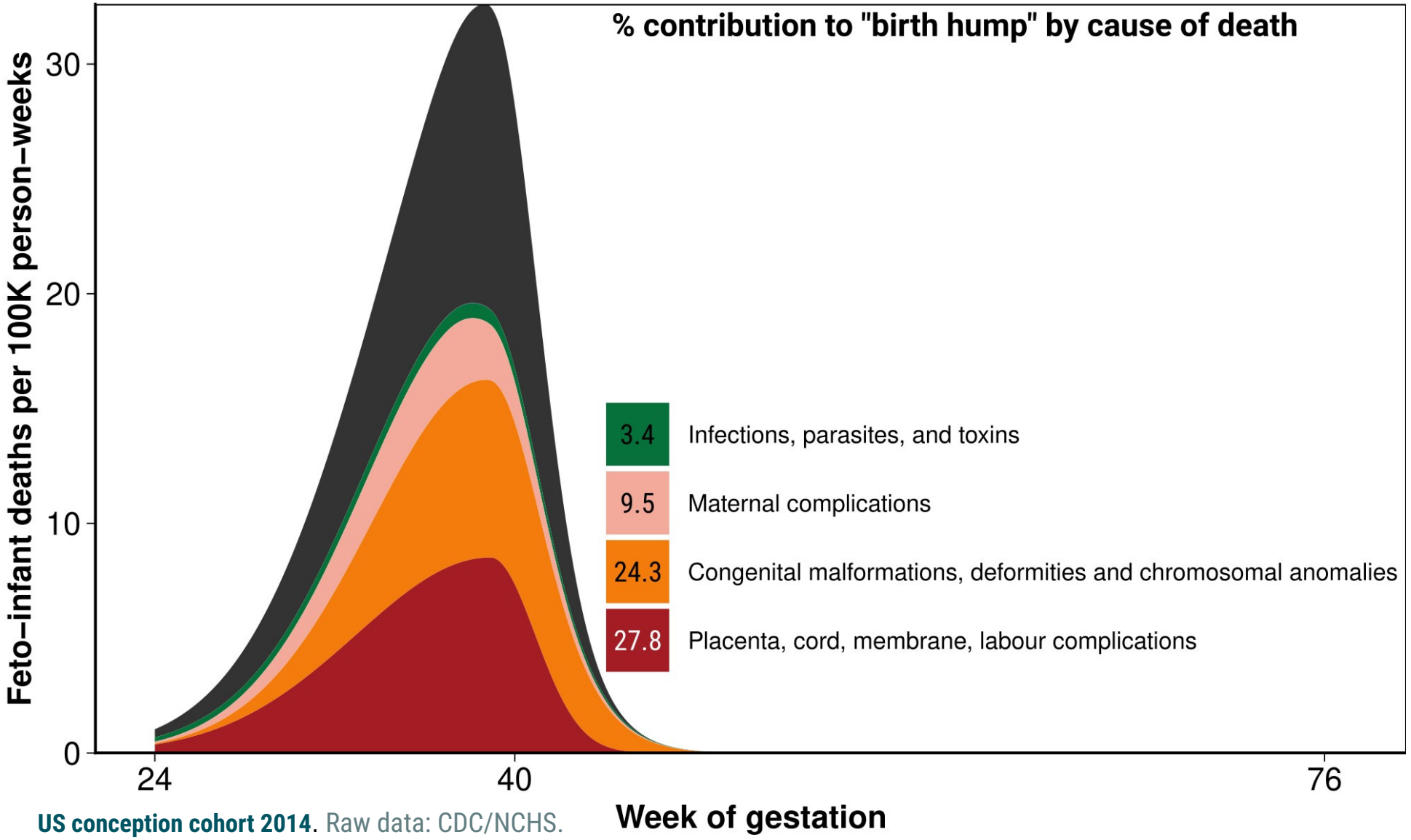

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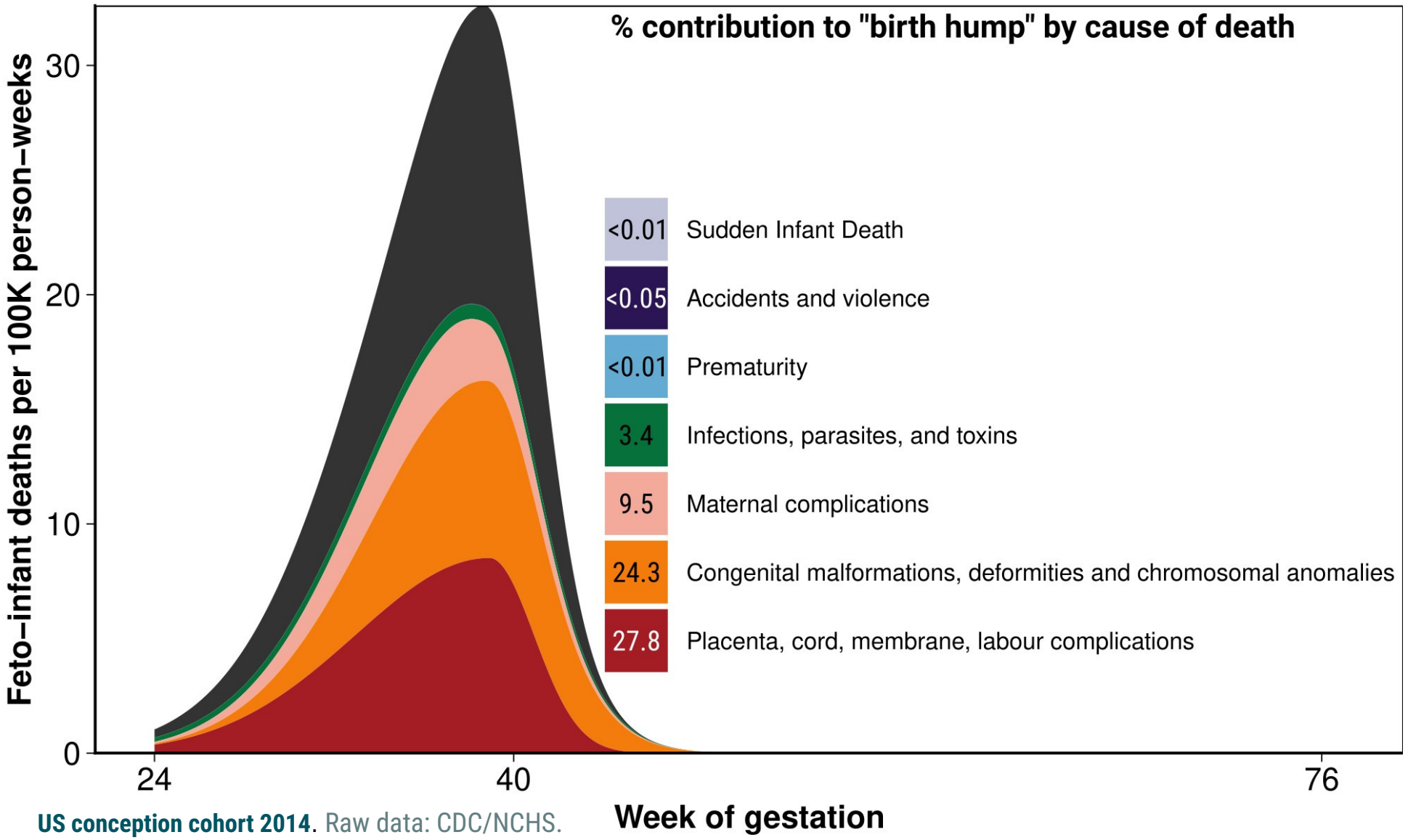

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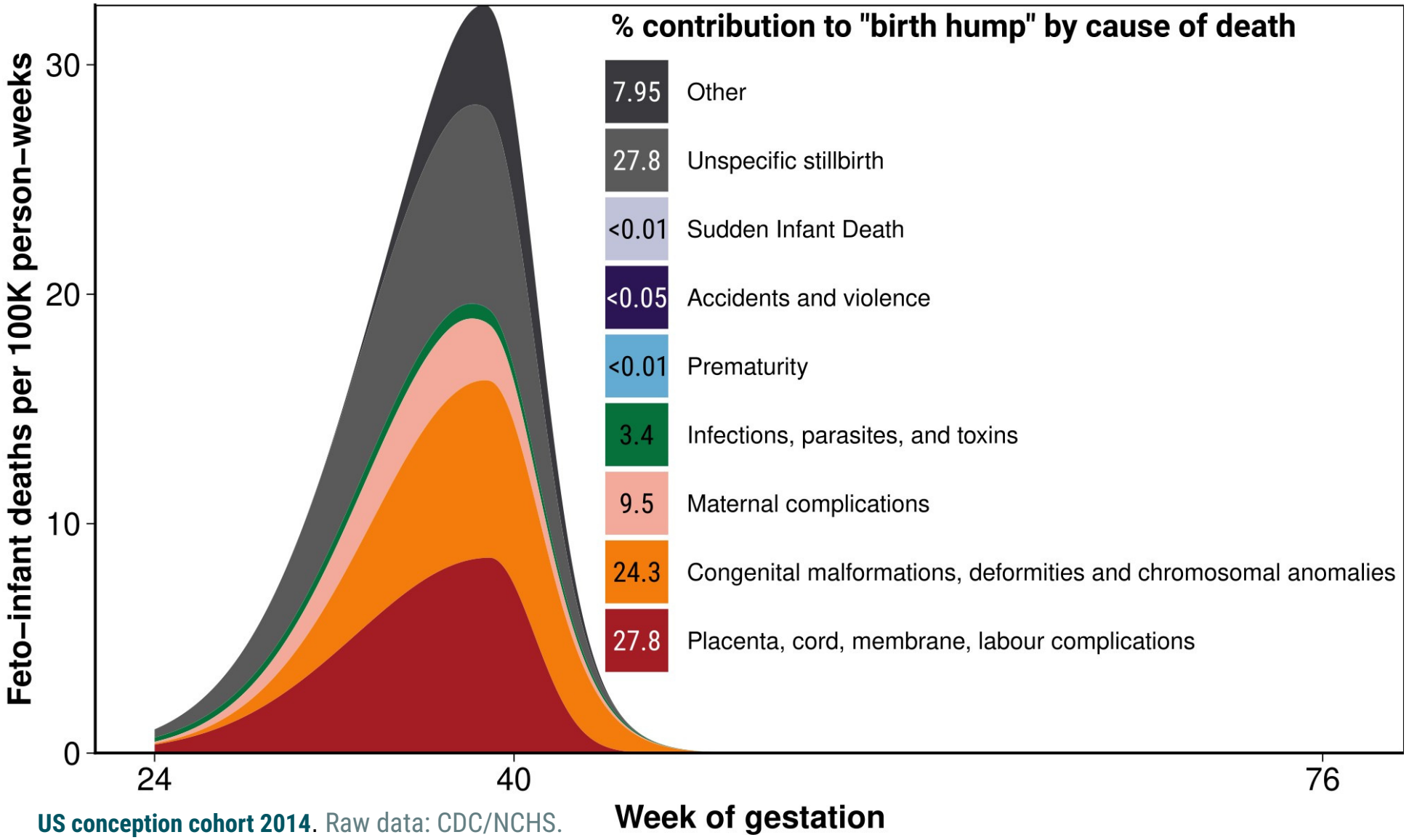

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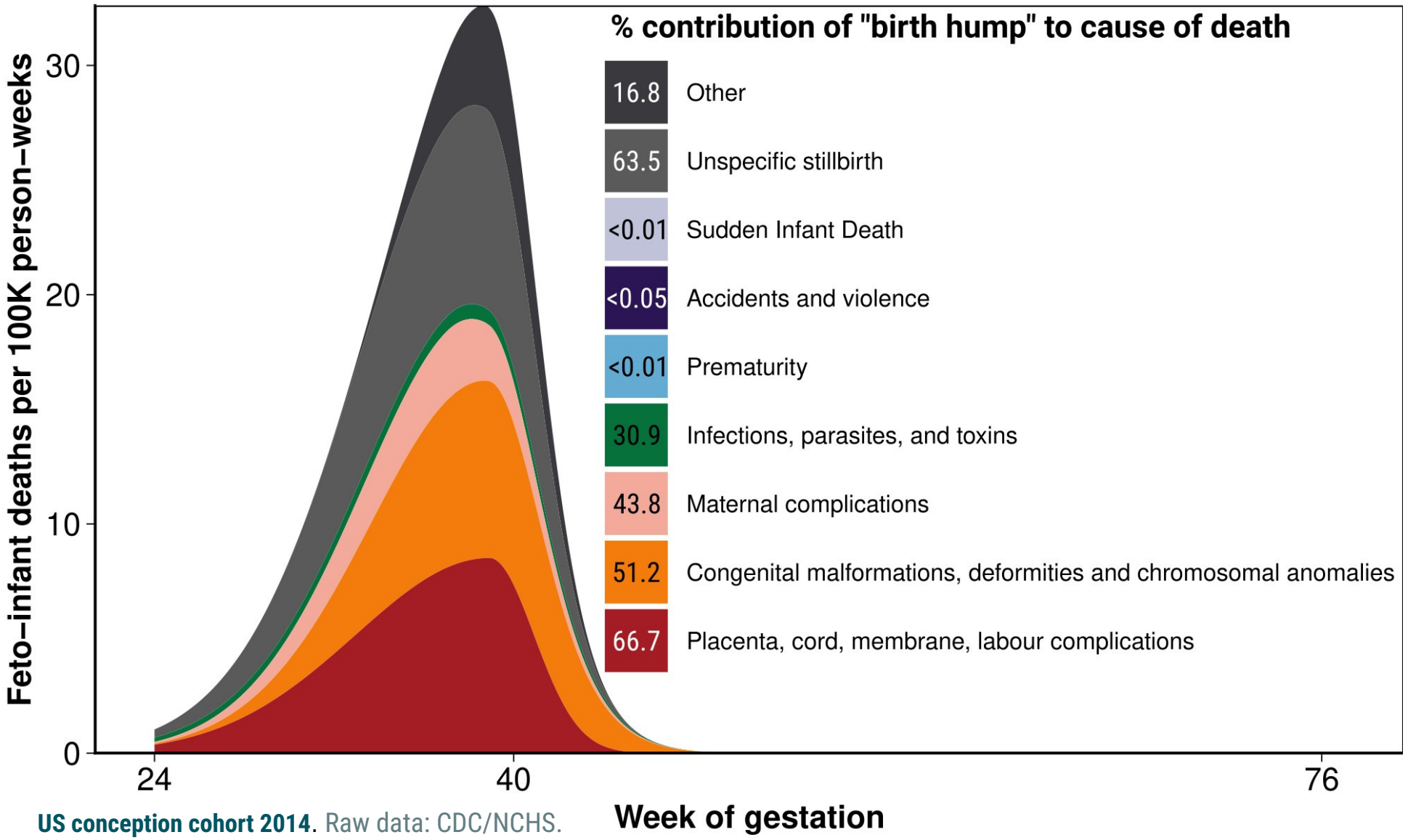
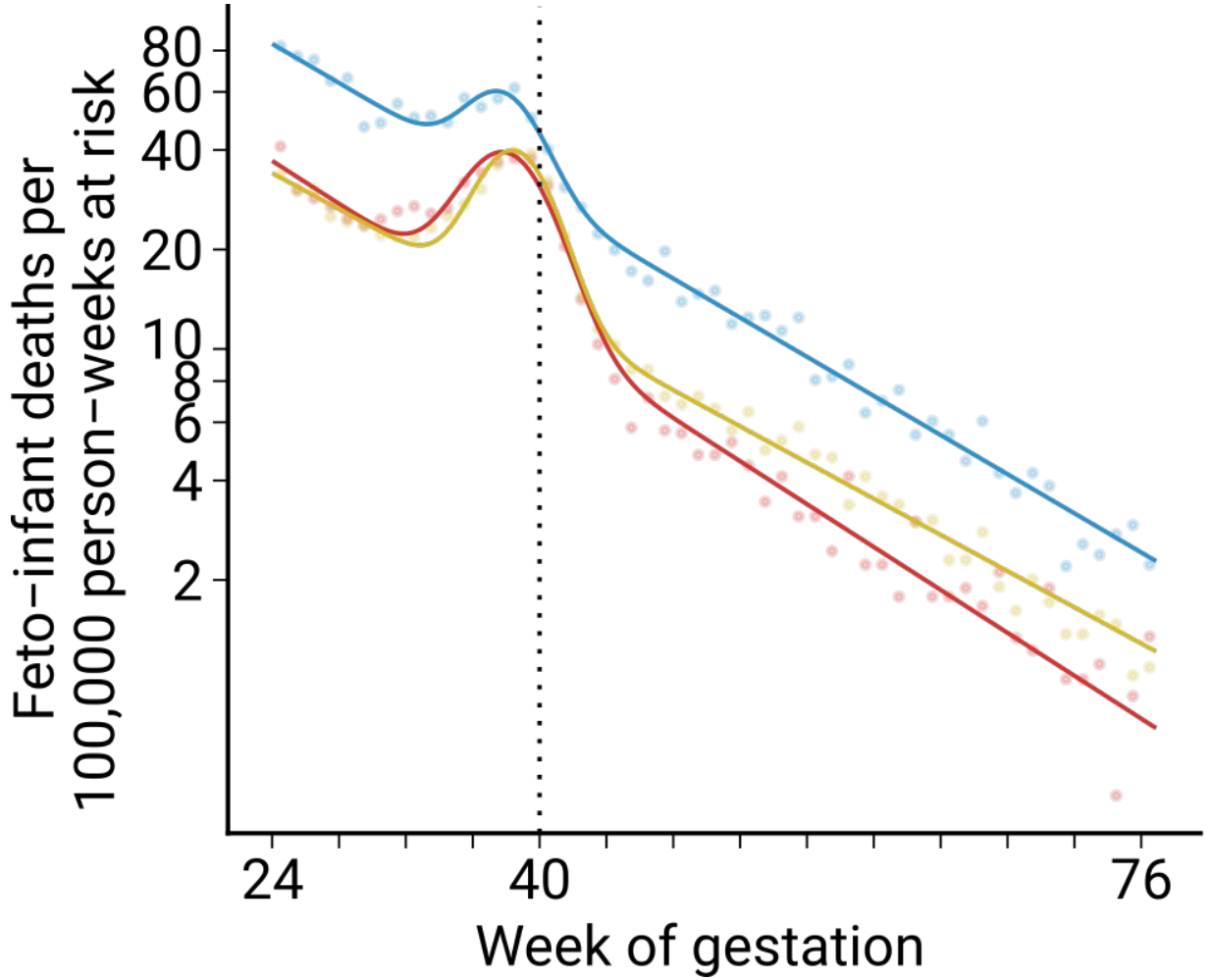


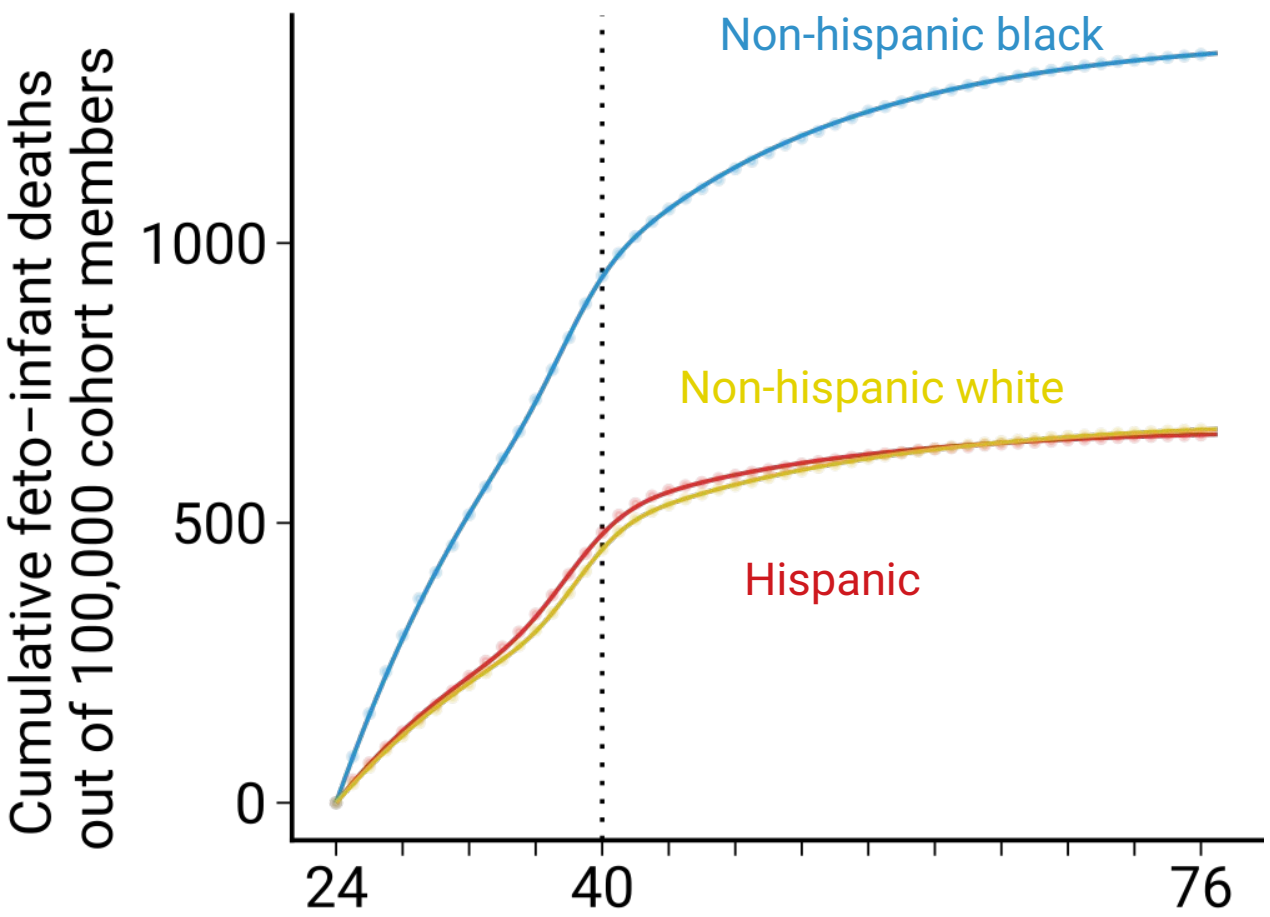
US conception cohort 2014. Raw data: CDC/NCHS.

Among those dying one year post fetal viability due to a given cause, **what share dies in relation to the birth hump?**

Deconstructing the “birth hump”

Combined feto-infant mortality by maternal origin among conception cohort 2014. *The dynamics of ontogenescence.* Raw data: CDC/NCHS.





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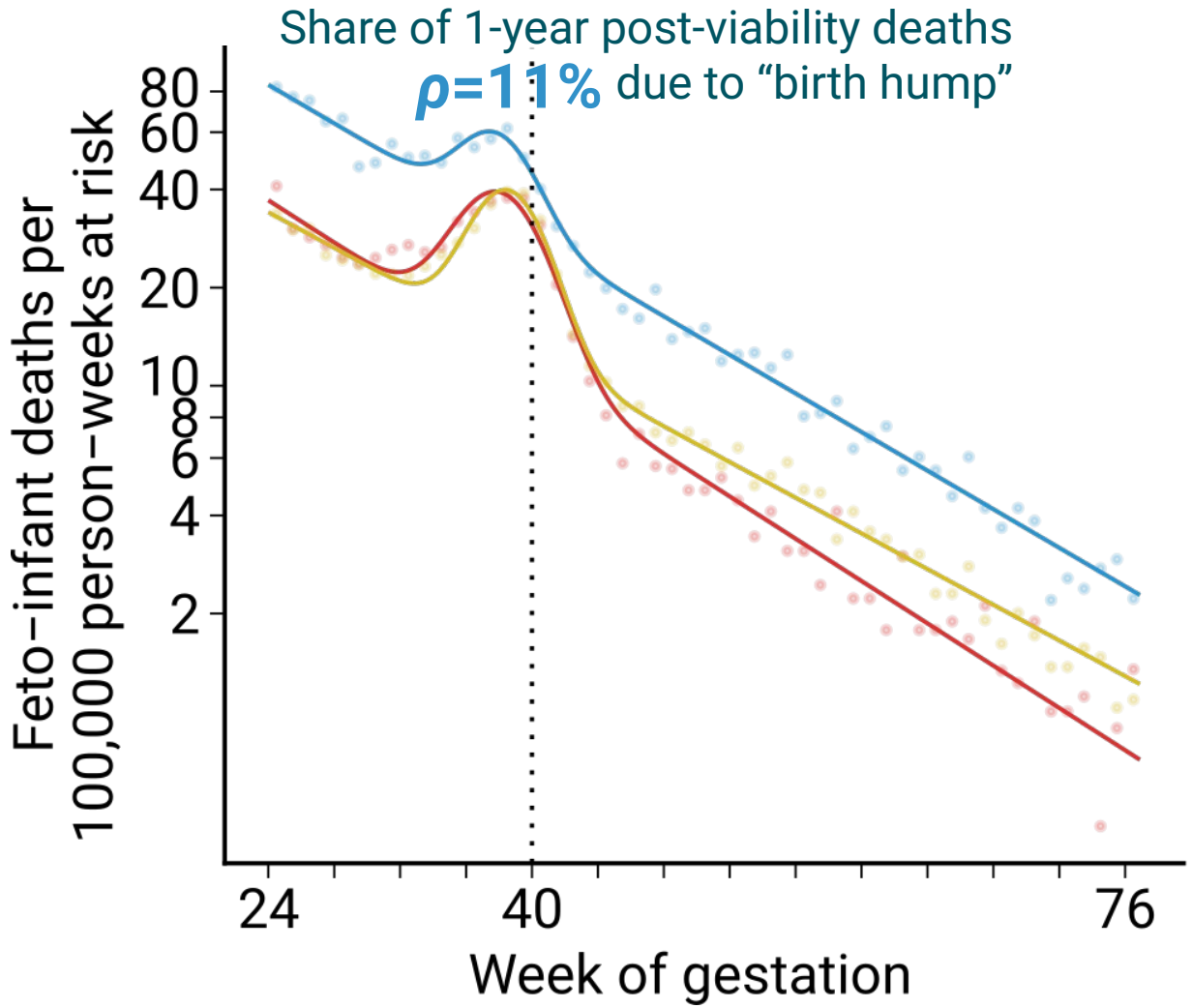

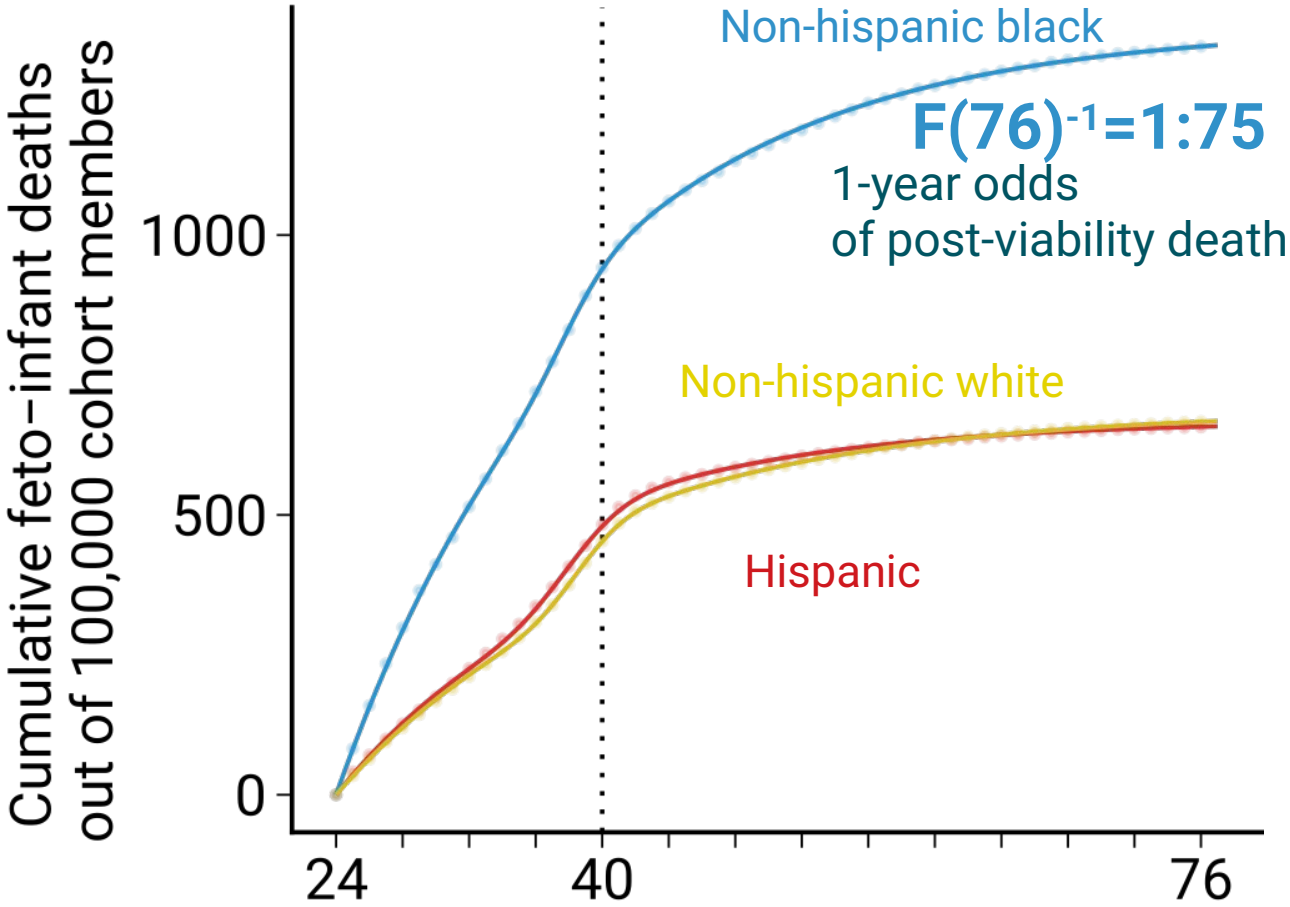

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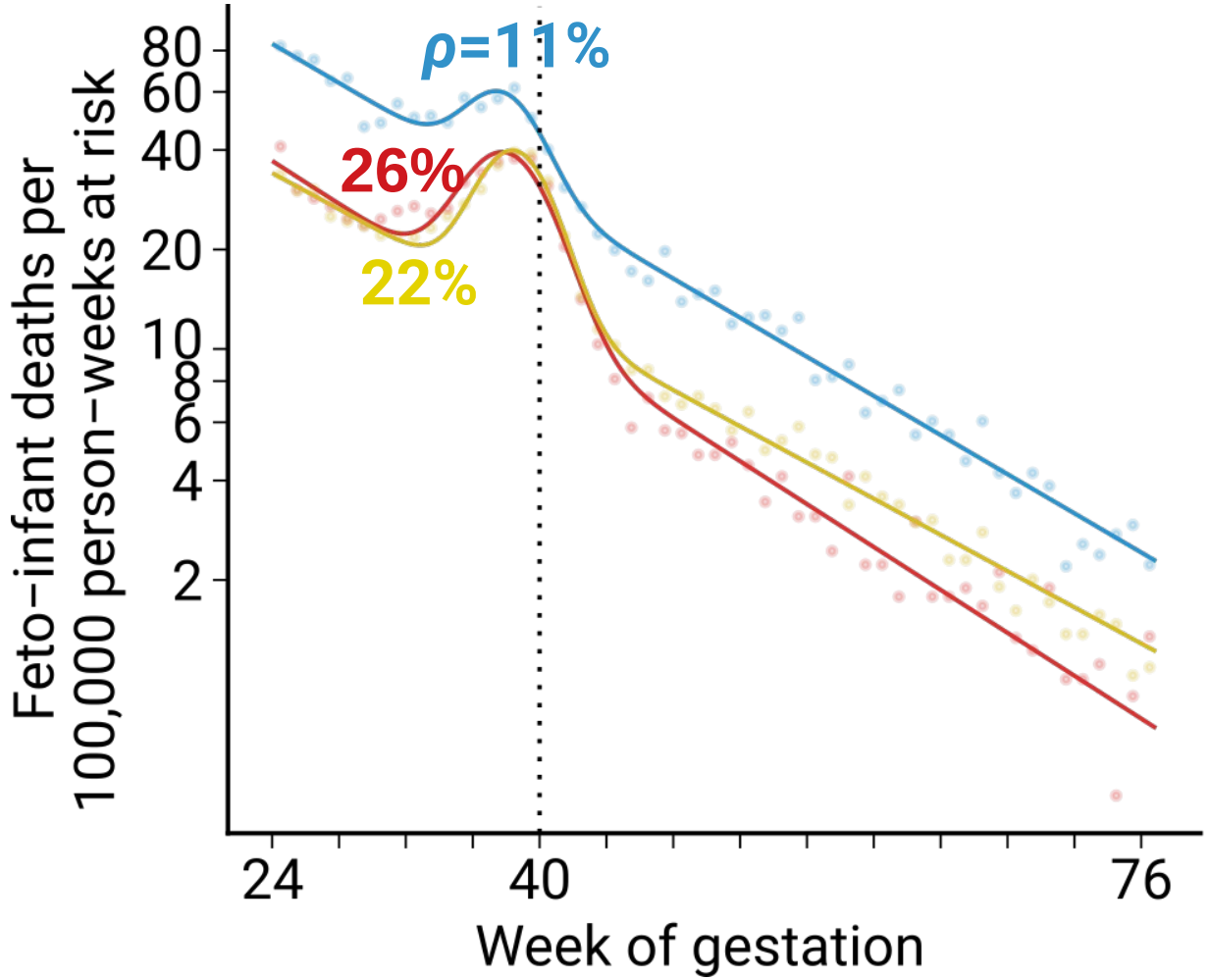
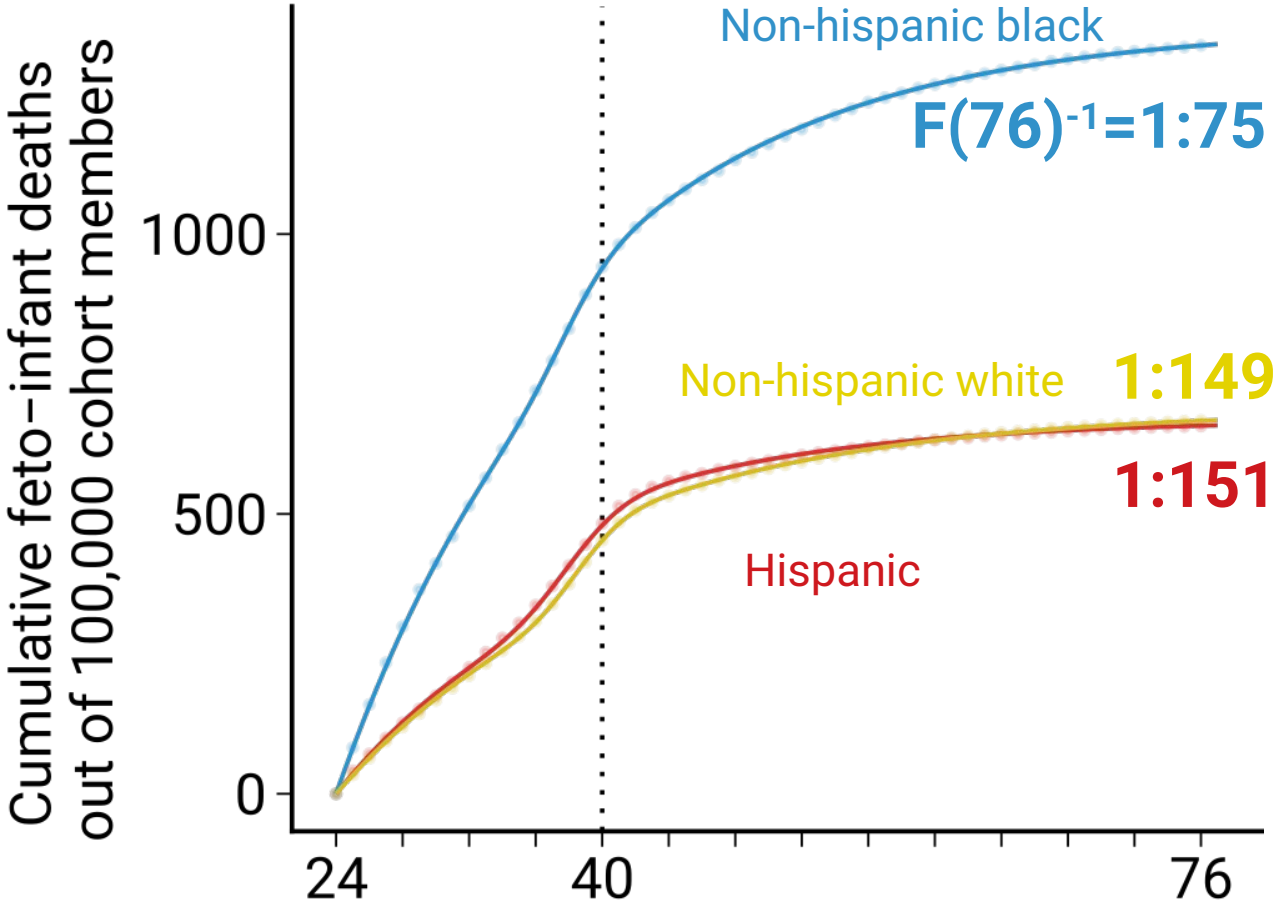
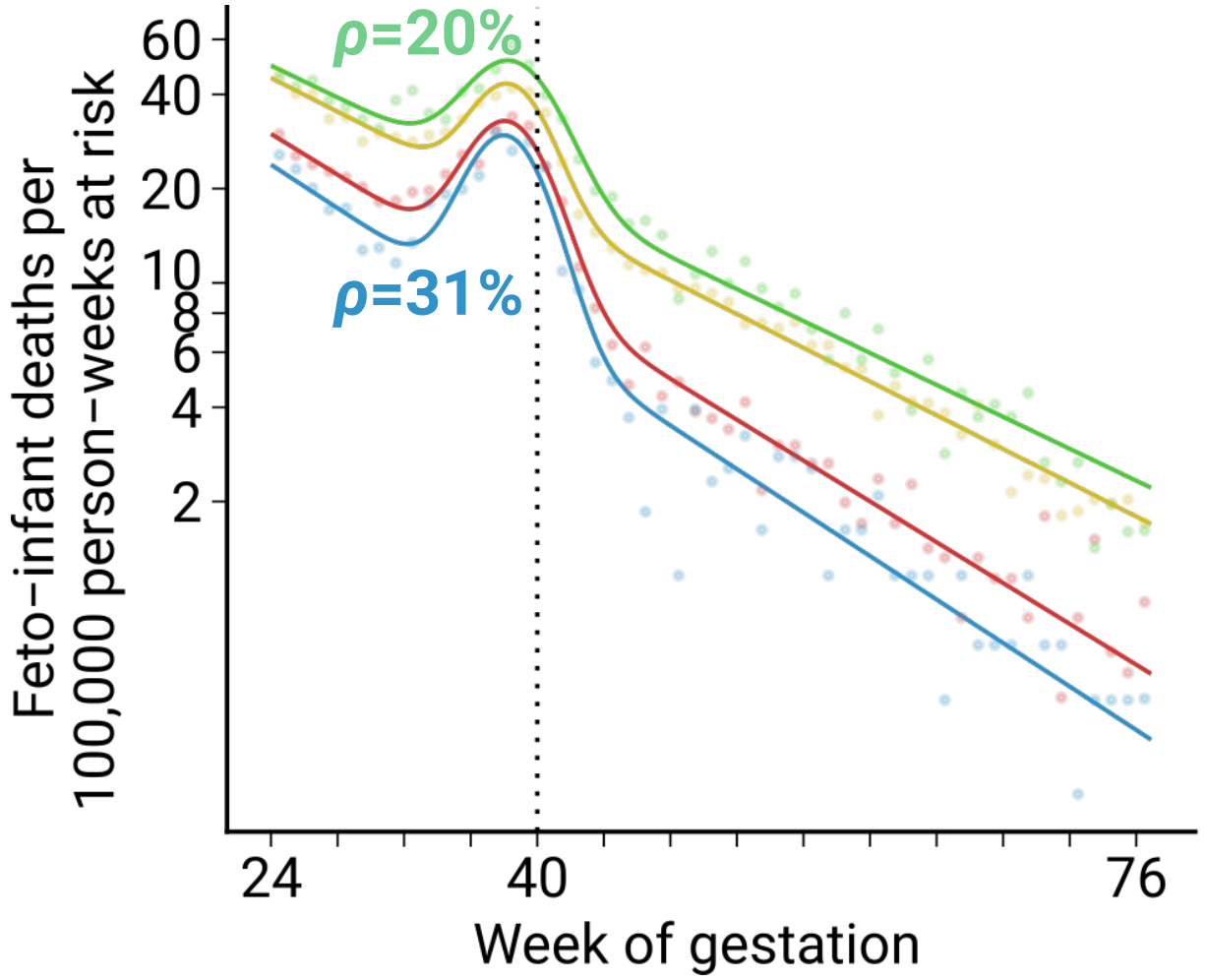
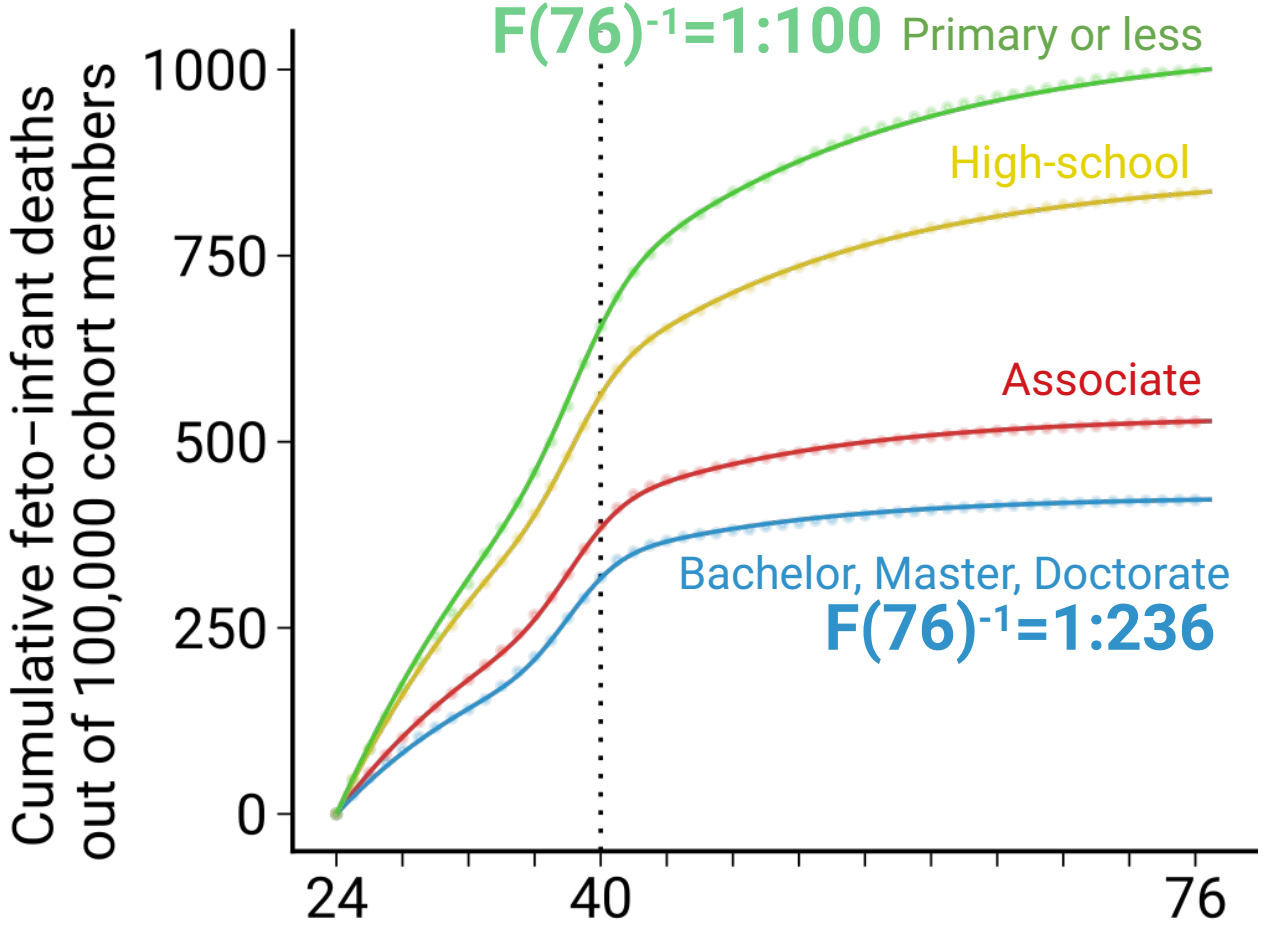




Deconstructing the “birth hump”

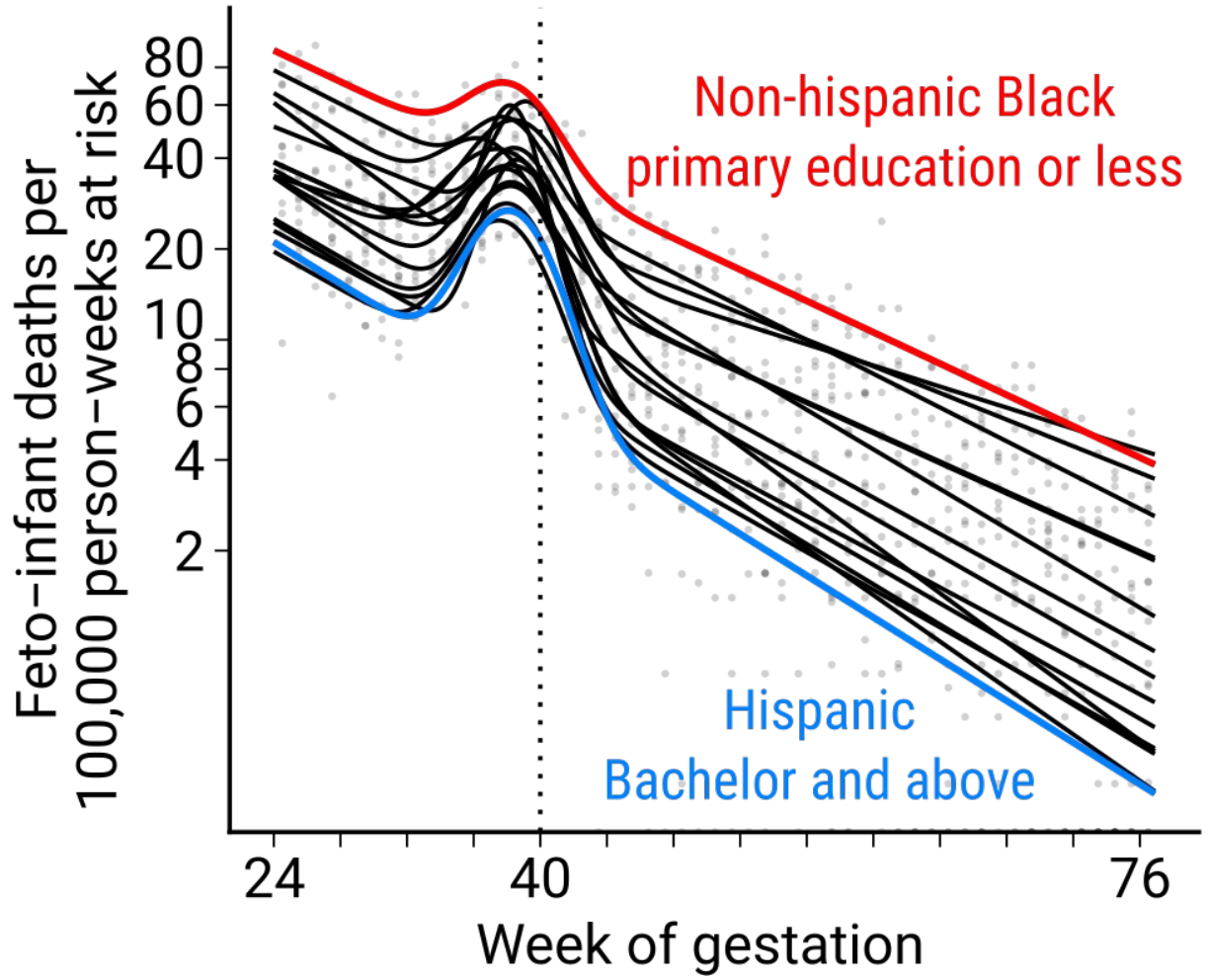
Combined feto-infant mortality by maternal education among conception cohort 2014. Raw data: CDC/NCHS.

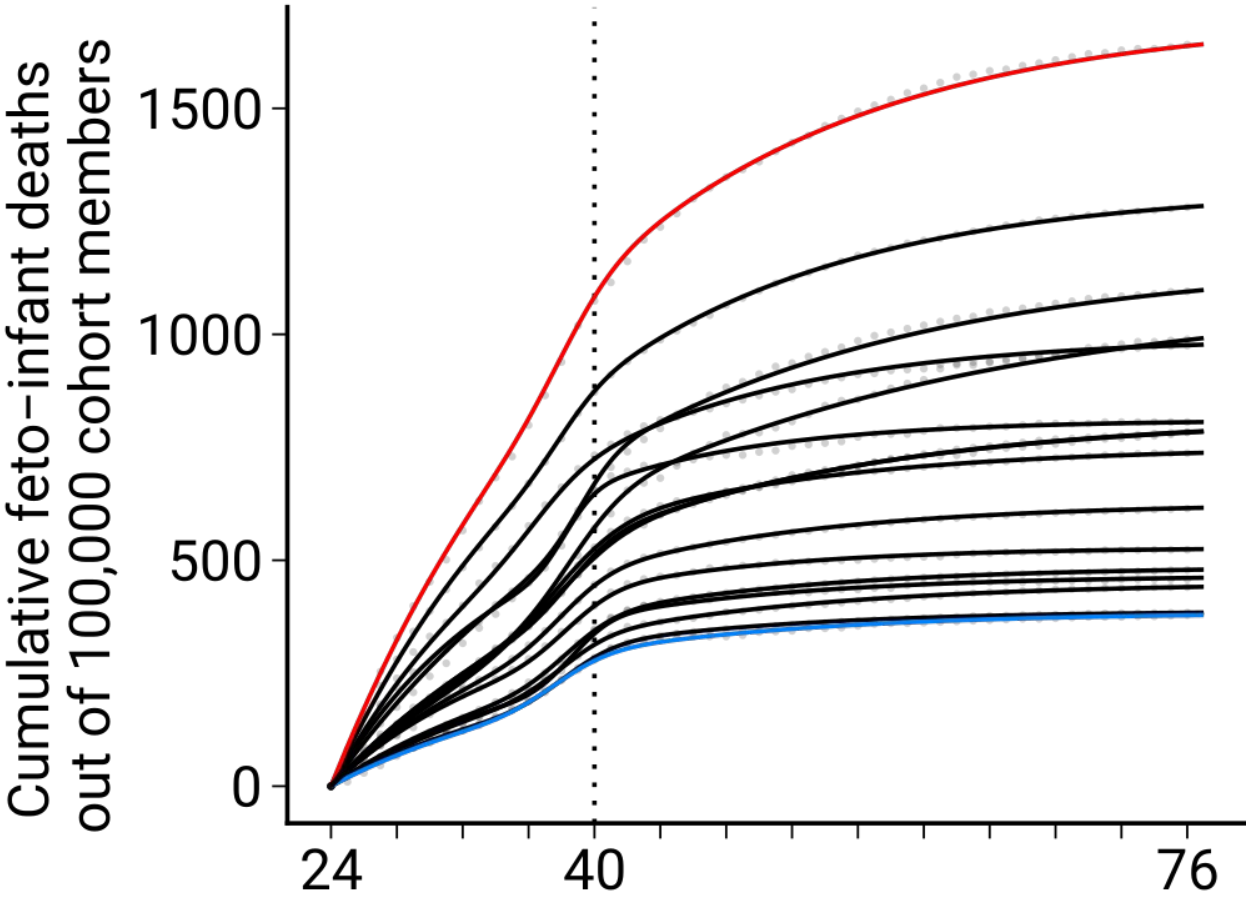




Mortality compression towards birth

Combined feto-infant mortality by maternal origin and education among conception cohort 2014. Raw data: CDC/NCHS.





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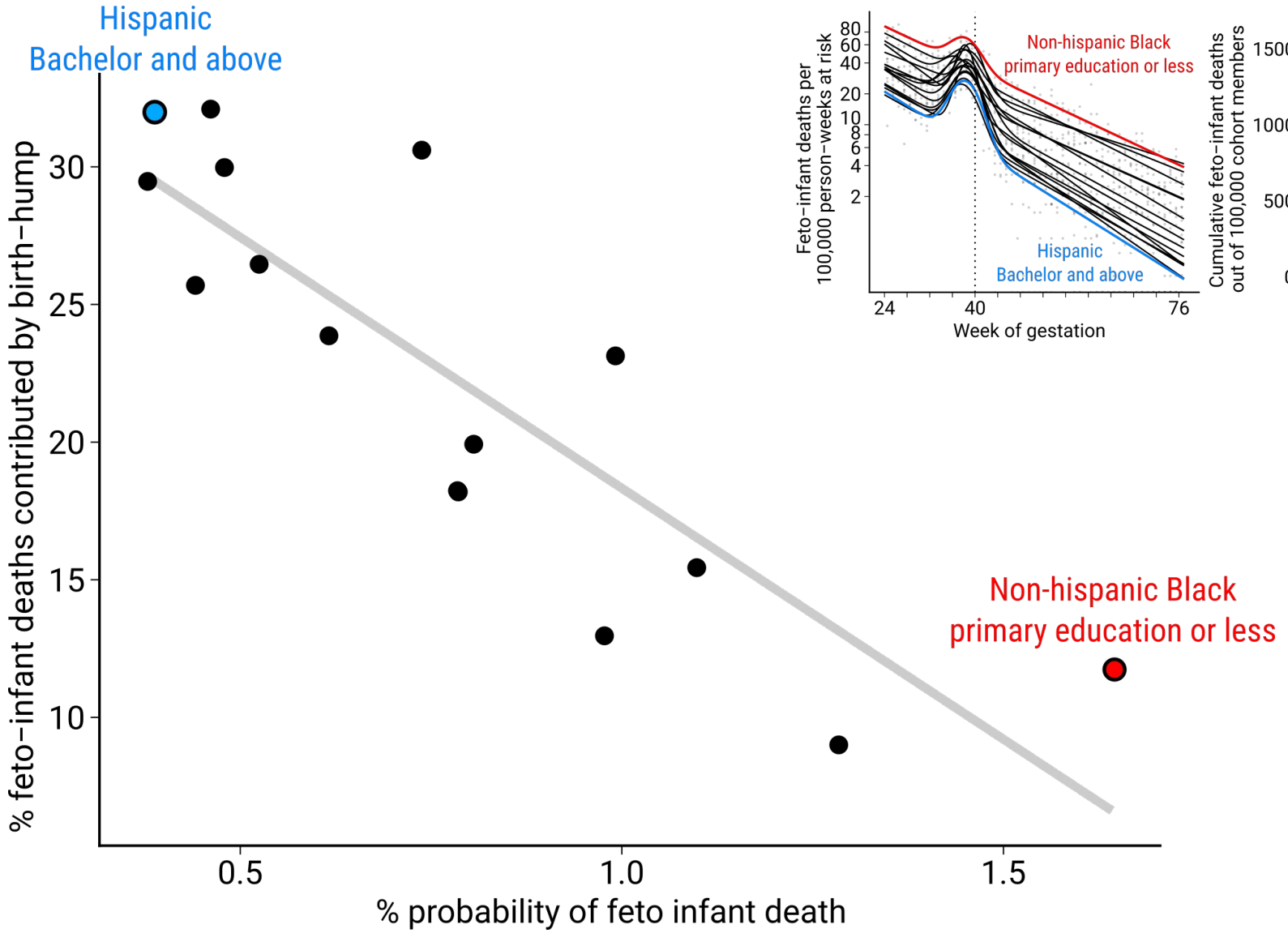

Reproducible analysis

github.com/jschoeley/bhump

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